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Non-Suitable Habitat a Cause for Declining Bobolink Populations in Northern Utah

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NON-SUITABLE HABITAT A CAUSE FOR DECLINING BOBOLINK POPULATIONS IN NORTHERN UTAH

by

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ABSTRACT

NON-SUITABLE HABITAT A CAUSE FOR DECLINING BOBOLINK POPULATIONS IN NORTHERN UTAH

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Bobolink, *Dolichonyx oryxivories,* populations are declining in Utah. I characterized the habitat conditions of known bobolink nesting sites in Utah and compared these conditions to those for nest sites in Wisconsin where bobolinks are abundant. My habitat assessment included identifying vegetation species, vegetation cover, pH, temperature, and precipitation at each site location. Vegetation cover different between Utah and Wisconsin nest sites. Precipitation varied for both locations with no correlation between water availability and bobolink presence. One possible driver for the reduction in bobolinks throughout Utah is the drastic increase in temperature. Other possible external factors include livestock grazing, edge distance, forb density, and the status of bobolinks as pests in South America.

ACKNOWLEDGEMENTS

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INTRODUCTION

The bobolink, *Dolichonyx oryxivories*, is famous for its round trip migration. Bobolinks travel 20,000 km round-trip between breeding and wintering grounds, making the journey one of the longest annual migrations of passerines[10]. Traditionally, summer nesting locations occurred across tall-grass and mixed-grass prairies in the Western United States[17]. The birds winter in South America[1] (figure 1, figure 3).

Bobolinks traditionally nest in native tall-grass and mixed-grass prairie habitats. However, since the conversion of many prairies to agriculture, the birds have adapted to nesting in cropland, especially alfalfa. Currently, the bobolink is disappearing from Northern Utah, a once popular nesting location, causing them to be listed as a sensitive species in the state of Utah[3]. A habitat assessment was performed to identify possible environmental differences causing the population shift out of Utah.

In summer 2013, habitat data was collected from three known nesting site locations throughout Utah (figure 2). The sites visited were Stoddard Slough Wildlife Management Area, East Canyon State Park, and The Great Salt Lake Shorelands Preserve. The vegetation species, land cover, pH, temperature, and precipitation were measured to understand the conditions of known nesting locations. The habitat data collected in Utah was compared to a base sample taken from nesting sites in Wisconsin, a state centered in the current bobolink range with high population numbers (Figure 4).

STUDY SPECIES

The Bobolink, *Dolichonyx oryxivories*, is a songbird measuring 6-8 inches in length with a 10-11 inch wingspan[1]. The males can easily be identified by the backwards tuxedo pattern and bright yellow head apparent during mating season[10]. The birds are ground nesters and prefer a grassland or meadow habitat, but will use agricultural land as an alternative[3]. Adults and fledglings can typically be found on or near the ground, as they feed and nest on the ground[10]. Nesting sites are found at the base of large forbs[12]. Bobolinks can have multiple nests in a given nesting period, with each clutch of eggs sired by more than one male[10]. The bird's diet consists of insects in the summer and seeds in the winter[1]. Common predators include the Cooper's hawk, gulls, garter snakes, milk snakes, skunks, owls, sandhill cranes, crows, and northern harriers[8, 9, 15, and 18]. Moreover, the bobolink is a protected species under the Migratory Bird Act[10].

Their breeding range and population have declined throughout Utah[3]. Available habitat has shrunk due to urban encroachment and different methods of agricultural management[3]. In the past 40 years, their population has decreased by 75% in the west[3]. The Bobolink is currently considered a sensitive species Utah by the Utah Division of Wildlife Resources, due to its declining population and range[3, 25].

STUDY AREA

I collected field data from three study sites within northern Utah: Stoddard Slough Wildlife Management Area (WMA), The Great Salt Lake Shorelands Preserve, and East Canyon State Park. Stoddard Slough WMA is a popular birding site, located within Morgan County. The Great Salt Lake Shorelands Preserve is a combination of fresh and salt water marshes, pools, and ponds along the eastern shore of the Great Salt Lake. The Shorelands Preserve is an important stop-over for migratory birds. East Canyon State Park is located in Morgan County and contains a 600 acre reservoir.

METHODS

For the habitat assessment, a pH tester, a 100 ft tape, and a 2 ft by 2 ft quadrat were used to quantify the vegetation and environment of three study sites: Stoddard Slough Wildlife Management Area, The Great Salt Lake Shorelands Preserve, and East Canyon State Park. These sites were chosen because they were areas monitored by the Utah Division of Wildlife Resources as possible nesting sites (Figure 2).

At each site location, I set up linear transects in three randomly selected locations. For each transect, I measured the following: pH, canopy cover, and vegetative species presence. Soil pH was measured at the beginning of each transect (Table 2). Every 10 feet along a transect, cover measurements were recorded using a quadrat frame to determine the percent (0-100%) cover of each study site (Table 3). The point intercept method every 10 feet was used to determine the species present at each transect per location (Figures 8-11).

After the field data were collected, I examined variation in climate factors using ArcGIS 10.2 and NASA Goddard climate data. A temperature analysis was performed to identify any rising or decreasing temperatures in the Bobolink's Utah and Wisconsin study sites (Figure 5-7). A precipitation analysis was performed to identify if changes in water availability could be behind the reduction of bobolinks in Utah (Table 4-6). Changes in temperature and precipitation, a result of climate change, could be causing the bird's preferred habitat range to shift eastward out of Utah.

RESULTS

The habitat analysis showed slightly different vegetation for the Utah nesting sites and the Wisconsin nesting sites (Tables 1-3). Wisconsin and Utah nesting sites have similar grass and forb cover (Table 4). Wisconsin nesting sites have a higher percentage of shrub and litter (Table 4). The vegetation species found in the Utah nesting sites can be identified in figures 8 through 11. Bobolinks rely heavily on grass and forb cover for protection and nesting. From this information, I concluded that changing habitat type is may not be the main cause behind the reduction in bobolink populations in Utah.

The temperature for both the Utah and the Wisconsin sites increased, however the western United States showed a severe temperature increase (figures 5, 6, and 7). This data leads to the conclusion that temperature, in relation to climate change, is a possible driver behind decrease in bobolink populations in Utah. The mid-western temperatures also increased on average, but the increase for the western populations was greater and more dramatic.

Precipitation rates for the Utah and the Wisconsin sites fluctuated, leaving the data too variable to identify a clear correlation between precipitation and bobolink abundance (tables 5, 6, and 7).

DISCUSSION

Some scientists, such as Renfrew, believe the bobolink is in decline due to land use changes, particularly the decline in meadows and hay fields[10]. Historical changes in precipitation may be responsible for the decline of bobolinks in the Western United States. Some research has shown that western populations of bobolinks may be relicts from an earlier time period, when the Western United States was wetter[16]. One possible cause of the decline is the age of the fields and pastures used by bobolinks after the decline in native grasslands. Bobolink density is higher in areas that have low total vegetation cover and high grass to legume ratios; these conditions are usually found in fields older than 8 years[15]. It is possible that the available grass areas have not reached their full bobolink habitat potential.

Of course, urban development plays a role in the bobolink decline. Research in New York has showed that bobolinks avoid roads, limiting the potential nesting locations[18]. The decline, links the decline of bobolinks in the Western United States may also be linked to wildlife management in their wintering grounds in South America. In South America, particularly Argentina and Bolivia, the bobolink is considered a pest species. The birds often inhabit ranch land and rice patties, angering local farmers. In South America the bobolinks are often scared off the land, poisoned, or sold into the pet industry[5, 6]. The birds experience high mortality rates in rice patties that use poisoning[20].

Bobolink abundance can increase with the proper conservation efforts. Grasslands need to be managed to prevent the negative effects of grazing, as heavily grazed pasture do not support bobolinks[21]. Heavy grazing removes the vegetation of the correct height, density, and litter that bobolinks require for protection and nesting building. If managed correctly, light grazing can be beneficial to the ecosystem and the bobolink though limiting shrub growth and litter build-up[21]. One management tool to minimize shrub growth is prescribed fire. Fire limits excessive shrub growth, but will have a short term negative effect on the bobolinks lasting for approximately 3 years[23].

Education about the conservation importance of the bobolink in South American countries can limit the decline of abundance due to death and removal of the birds in their wintering grounds. Education can help promote healthy ranching and farming practices that do not interfere with the migratory birds[22]. Protected grasslands in both South and North America will help increase abundance. Possible protected grasslands include Wildlife Management Areas, Important Bird Areas, and ranches that promote the necessary habitat to support the sensitive bobolink[10].

Bobolinks may eventually reestablish in the Western United States. The birds in the past have proved to adapt well to environmental changes. Some researchers suggest that the bobolink numbers may rebound to previously recorded abundance[10].

CONCLUSIONS

Bobolinks prefer meadow habitats, tall grasses, and hay fields[10]. The grass and forb cover for Utah and Wisconsin nesting sites are similar, indicating factors other than specific plant species are causing the decline in the Western United States. The Utah three study sites had high grass cover, similar to (but still less than) the Wisconsin sites. The Utah study sites contained fewer forbs than the Wisconsin base sites. Another possible factor, the age of the grasses and forbs, may influence the abundance of bobolinks.

The percent cover of grasses and forbs for the receding and central nesting locations were similar, indicating biological conditions other than grassland species present were the cause behind the bobolink population reduction in Utah. Changes in the grasslands due to development could decrease bobolink abundance by decreasing the edge distance from nesting sites to urban areas and roads[10]. Some researchers have shown that bobolink populations decline in grazed sites[24]. Many open types of grassland in the Western United States are grazed, possibly contributing to the decline in bobolink abundance. Other possible reasons behind the decline in abundance area nest disturbance and predation. Grasslands and fields that are mowed or harvested can damage nests, eggs, and fledglings [11, 14, 15].

LITERATURE CITED

1. The Cornell Lab of Ornithology. http://www.allaboutbirds.org/guide/bobolink/lifehistory. Published January 1, 2011. Accessed November 17, 2014.
2. Smithsonian Institution. (2013, January 28). The Prairie Home Companion. http://nationalzoo.si.edu/scbi/migratorybirds/featured_birds/?id=289. Published January 28, 2013. Accessed November 17, 2014.
3. The Bobolink Project | Helping Farmers Protect Grassland Birds. Retrieved October 24, 2014, http://www.bobolinkproject.com/why_bobolinks.php. Published January 1, 2014. Accessed October 24, 2014.
4. Nesting Ecology and Nesting Habitat Requirements of Ohio's Grassland-nesting Birds: A Literature Review. USGS Website. http://www.npwrc.usgs.gov/resource/birds/ohionest/bobolink.htm. Publish February 1, 2013. Accessed October 23, 2014.
5. Pettingill Jr. O. Winter of the Bobolink. *Audubon*. 1983; 85(3): 102-109.
6. Sick H. Birds in Brazil. *Princeton University Press*, Princeton, NJ. 11993.
7. Bollinger E, Gavin T. Responses of nesting Bobolink (Dolichonyx oryzivorous) to habitat edges. *The Auk*. 2004; 121(3): 767-776.
8. Gabrielson I. Factors contributing to the destruction of bird's nests and eggs. *Bird Lore.* 1992; 24: 136-139.
9. Meag H. Food habitats of nesting Cooper's Hawk and Goshawks in New York and Pennsylvannia. *The Wilson Bulletin.* 1959; 71: 169-174.
10. Renfrew R, Strong A, Perlut N, Martin S, Gavin T. Bobolink (Dolichonyx oryzivorous). *The Birds of North America Online (A. Poole, Ed.)*. Ithaca: Cornell Lab of Ornithology. 2015. Retried from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/176. doi:10.2173/bna.176
11. Bollinger E, Bollinger P, Gavin T. Effects of hay-cropping on eastern populations of the Bobolink. *The Wildlife Society Bulletin*. 1990; 18: 142-150.
12. Martin S. Polygyny in the Bobolink: habitat quality and the adaptive complex. *Phd Thesis. Oregon State University, Corvallis*. 1971.
13. Wittenberger J. Habitat selection and the evolution of polygyny in the Bobolinks (Dolichonyx oryzivorus). *Phd Thesis. University of California at Davis, Davis*. 1976.
14. Bollinger E, Gavin T. Eastern Bobolink populations: ecology and conservation in an agricultural landscape. *Ecology and Conservation in Neotropical Migrant Landbirds. Smithsonian Institution Scholarly Press*, Washington, DC. 1992; 497-506.
15. Bollinger E. Breeding dispersion and reproductive success of Bobolinks in an agricultural landscape. *Phd Thesis. Cornell University, Ithaca, NY*. 1988.
16. Hamilton III W. Bobolink migratory pathways and their experimental analysis under night skies. *The Auk*. 1962; 79: 208-233.
17. Bent A. Life histories of North American blackbirds, orioles, tanagers, and their allies. *The Bulletin of the Unites States National Museum*. 1958; 211:28-52.
18. Wittenberger J. The breeding biology of an isolated Bobolink population in Oregon. *Condor*. 1978; 80: 355-371.

19. Gavin T A, E K Bollinger. Responses of nesting bobolinks (Dolichonyx oyrzivorus) to habitat edges. *Faculty Research and Creative Activity*. 2004; Paper 18. http://thekeep.eiu.edu/bio_fac/18
20. R B Renfrew, A M Saavedra. Ecology and conservation of bobolinks in rice production in regions of Bolivia. Ornitologia Neotropical. 2007; 18: 61-73.
21. R B Renfrew, C A Ribic. Influence of topography on density of grassland passerines in Wisconsin pastures. America Midland Naturalist. 2002; 147: 315-325.
22. D Giacomo, A F Parera. 20 areas prioritarias para la conservacion de las aves migratorias nearticas en los pastizales delconsour de Sudamerica. Aves Argentinas/Asociacion Ornitologica del Plata, Buenos Aires, Argentina. 2008.
23. J R Herkert. Bobolink (Dolichonyx oyrzivorus) population decline in agricultural landscapes in Midwestern USA. Biological Conservation. 1997; 80(1): 107-112.
24. J J Nocera, G J Parsons, G R Milton, A H Fredeen. Compatibility of delayed cutting regime with bird breeding and hay nutritional quality. *Agriculture, Ecosystems, and Environment*. 2005; 107: 245-253.
25. State of Utah, Department of Natural Resources Division of Wildlife Resources. Utah Sensitive Species List. 2015. Accessed online: http://dwrcdc.nr.utah.gov/ucdc/ViewReports/SS_List.pdf.
26. J Wolf, R Baker, E Reed. An assessment of vegetation cover for grassland bird breeding habitat in southeastern Wisconsin. Bird Populations. 2012; 11: 22-29.

TABLES AND FIGURES

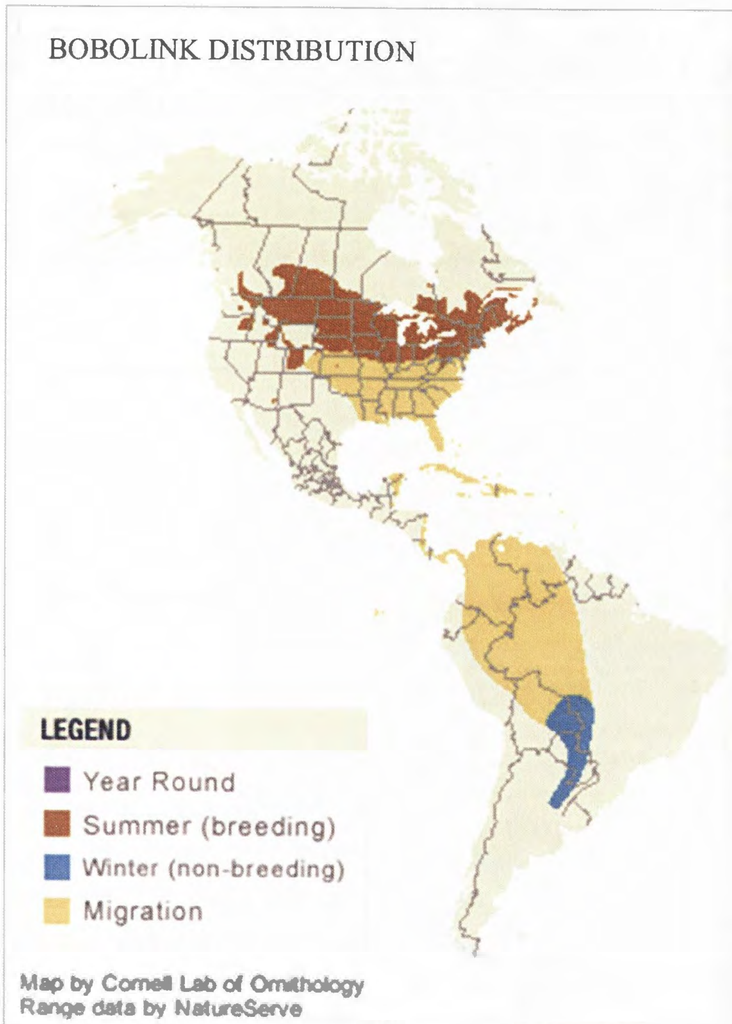

Figure 1. The bobolink distribution. Courtesy of the Cornell Lab of Ornithology.

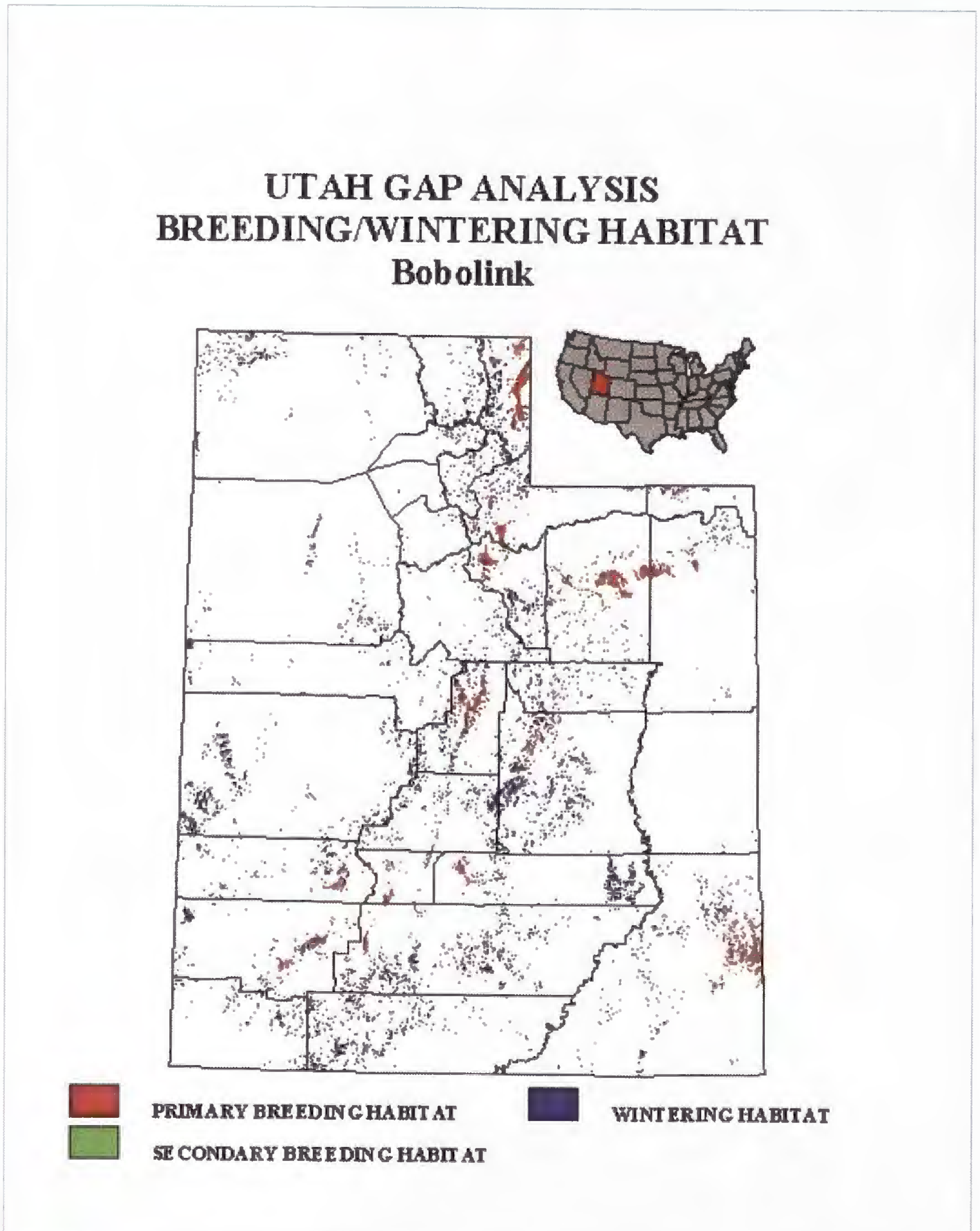

Figure 2. The bobolink distribution within the state of Utah. Courtesy of the Utah Division of Wildlife Resources.

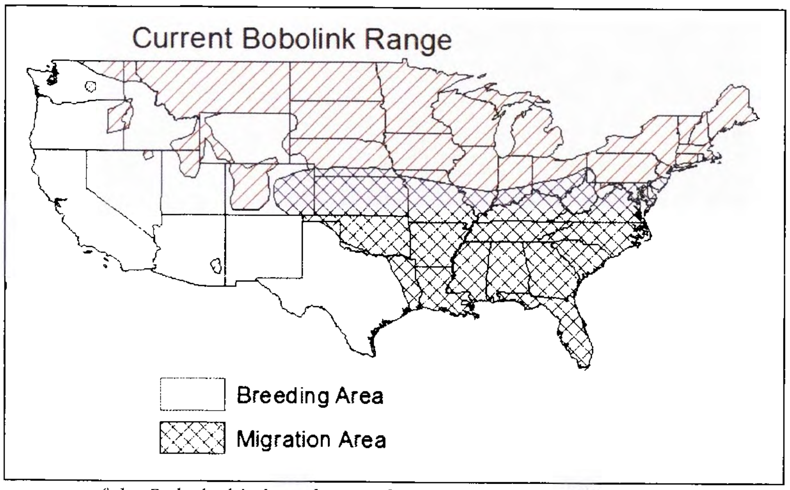

Figure 3. The extent of the Bobolink's breeding and nesting habitat within the United States of America.

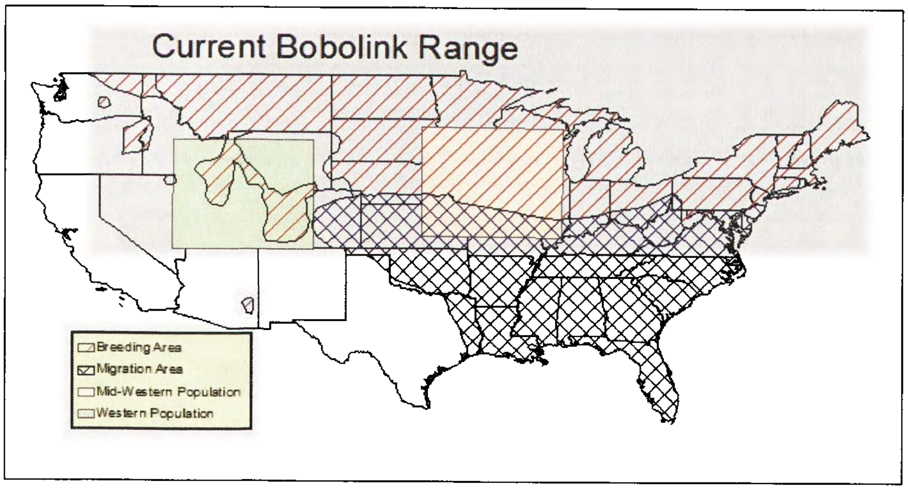

Figure 4. STUDY AREAS. The two study areas allow for comparisons between the sparse Western population and the abundant Mid-western population.

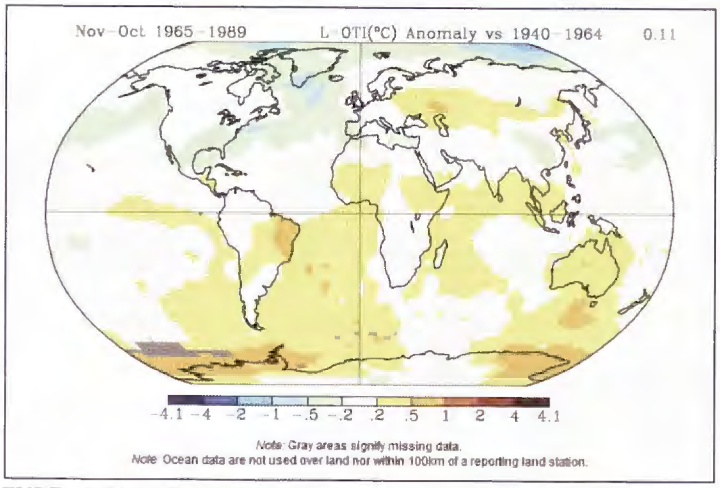

Figure 5. TEMPERATURE ANOMALIES 1965-1989. The temperature deviations from the average for 1965-1989. The 0.11 in the upper right hand corner indicates that on average the earth warmed 0.11°C for the 1965-1989 time frame when compared to the 1940-1964 time frame.

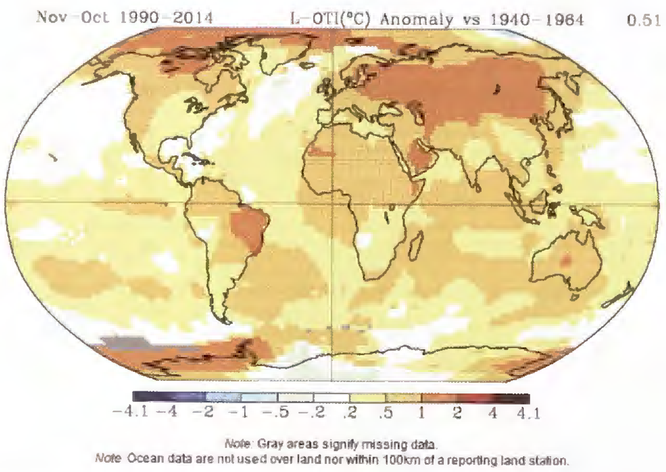

Figure 6. TEMPERATURE ANOMALIES 1990-2014. The temperature anomalies, or deviations from the average, for 1990-2014. The 0.51 in the upper right hand corner indicates that on average the earth warmed 0.51°C for the 1990-2014 time frame when compared to the 1940-1964 time frame.

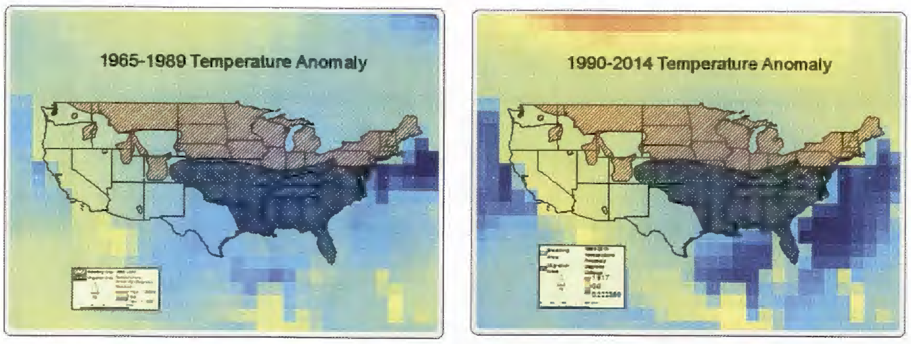

Figure 7. TEMPERATURE DEVIATIONS WITHIN BOBOLINK HABITAT. The fluctuating temperatures within Bobolink habitat across a span of 50 years (in two 25 year segments). The 1990-2014 time frame shows more warming than the 1965-1989 time frame, using 1940-1964 as a baseline.

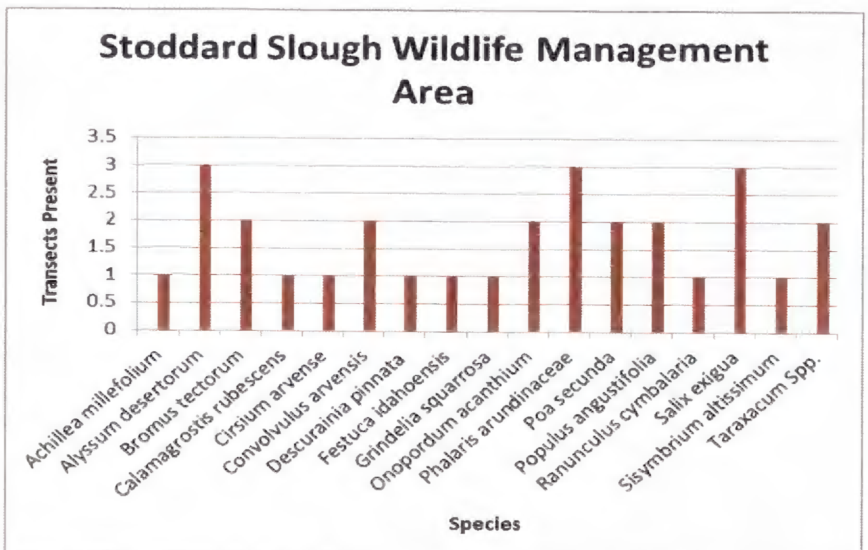

Figure 8. The species present along the three transects at the Stoddard Slough Wildlife management Area.

Figure 9. The species present along the three transects at the Great Salt Lake Shorelands Preserve.

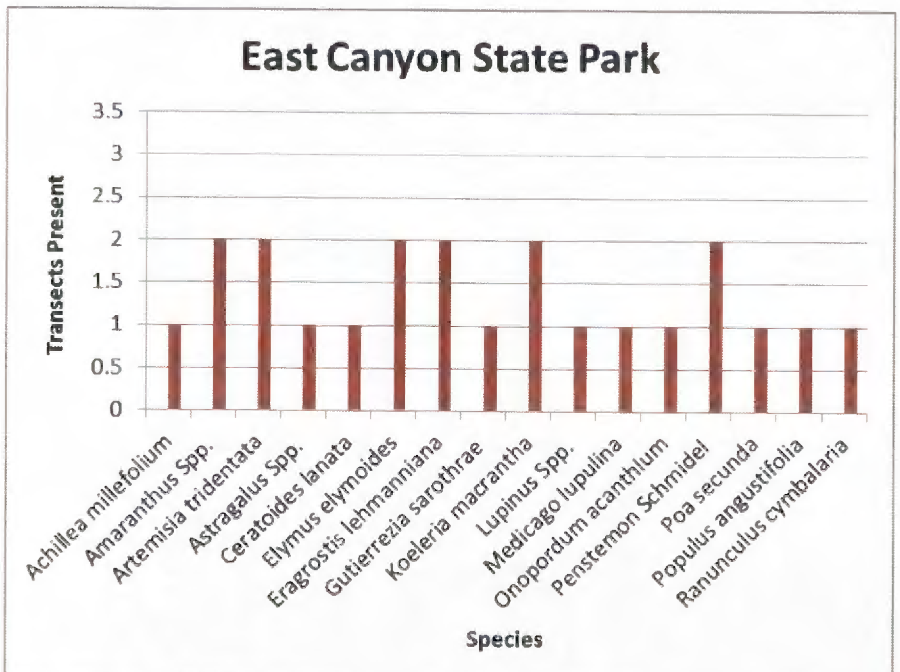

Figure 10. The species present along the three transects at East Canyon State Park.

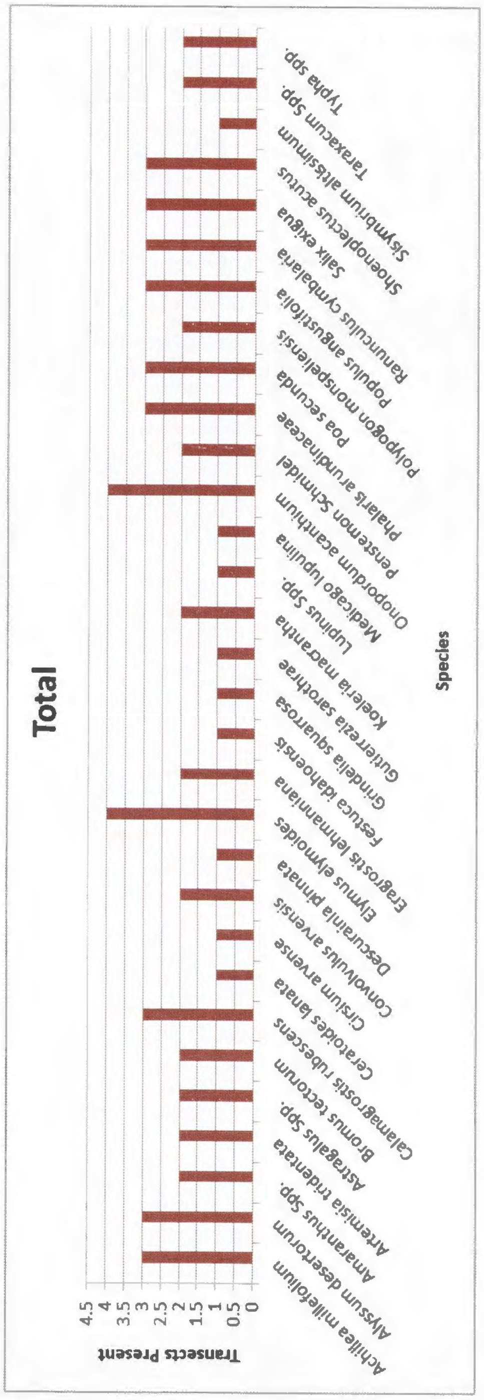

Figure 11. Species present along transects measured for the three Utah study sites: Stoddard Slough Wildlife Management Area, The Great Salt Lake Shorelands Preserve, and East Canyon State Park.

Wisconsin Territory and Nesting Sites[26]			
Wisconsin: Territories		Wisconsin: Nesting Sites	
Grass Cover	76%	Woody Cover	25%
Forb Cover	22%	Herbaceous Vegetation	78%
Bare Ground	2%	Litter Cover	12%
		Bare Ground	5%
Source: USGS, 2014			

Table 1. The habitat assessment of the Wisconsin sites.

Utah Study Site	Average pH Level
East Canyon State Park	7.0
The Great Salt lake Shorelands Preserve	7.27
Stoddard Slough Wildlife Management Area	7.37

Table 2. The average pH levels for all transects located in each study site. The study sites were East Canyon State park, The Great Salt Lake Shorelands Preserve, and Stoddard Slough Wildlife Management Area.

Average Ground Cover for All Utah Study Sites *Study Sites: East Canyon State Park, The Great Salt Lake Shorelands Preserve, and Stoddard Slough Wildlife Management Area*	
Cover Type	**Percent Cover**
Grass	61.11
Soil	15.13
Forb	10.80
Litter	5.91
Shrub	4.89
Rock	1.35
Scat	0.47
Water	0.25
Total	99.91%

Table 3. The results from the habitat assessment for the three study sites: East Canyon State Park, The Great Salt Lake Shorelands Preserve, and Stoddard Slough Wildlife Management Area.

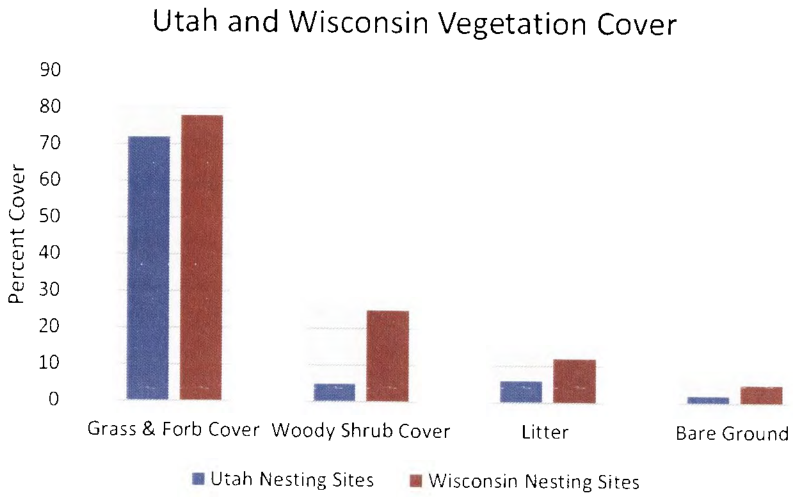

Table 4: Comparison of Utah and Wisconsin nest site vegetation cover.

		Min. Precip. (mm)					Max. Precip. (mm)					Mean Precip. (mm)					Sum Precip. (mm)				
		LGM	MID	CUR	2050	2070	LGM	MID	CUR	2050	2070	LGM	MID	CUR	2050	2070	LGM	MID	CUR	2050	2070
Jan.	W	5	5	5	5	5	109	111	109	110	101	28.46	30.27	27.06	28.12	25.51	7585	8067	114263	118769	107724
	MW	8	10	10	10	9	60	67	80	89	68	22.22	26.85	27.87	30.39	23.34	5922	7156	117682	128360	98569
Feb.	W	4	5	4	3	4	98	98	104	91	101	23.35	25.46	24.63	21.86	23.32	6223	6785	104028	922314	98492
	MW	7	13	12	11	12	58	77	83	78	78	19.67	28.8	29.01	25.94	29.47	5241	7675	122530	109529	124456
Mar.	W	5	9	6	6	6	94	112	117	136	127	26.13	32.93	31.3	33.2	32.88	6962	8777	132180	140221	138849
	MW	13	26	21	25	18	83	115	121	156	138	39.83	61.49	60.73	80.48	63.48	10615	16387	256487	339864	268072
Apr.	W	5	10	6	4	6	70	93	90	104	97	24.96	37.14	31.85	31.53	34.42	6652	9897	134492	133151	145359
	MW	21	29	25	29	28	89	108	112	101	105	61.62	75.27	80.63	78.55	76.64	16423	20058	340506	331747	323673
May	W	6	10	5	5	3	50	86	85	89	86	22.12	46.75	36.92	36.97	33.25	5894	12457	155920	156143	140429
	MW	34	37	30	28	34	131	141	131	151	151	92.58	105.3	100.9	113.44	112.2	24671	28049	426090	479068	473741
Jun.	W	3	4	3	3	3	48	88	83	90	89	23.31	35.59	30.01	34.48	32.17	6211	8952	126731	145627	135842
	MW	46	59	53	50	60	146	149	150	170	150	100.1	113.3	108.1	121.48	120.4	26678	30199	456475	513023	508343
Jul.	W	6	6	5	5	5	83	106	114	120	144	30.63	33.29	31.06	25.15	34.55	8162	8872	131193	106225	145896
	MW	46	73	62	70	63	125	142	121	147	133	96.57	112.1	99.27	113.88	100.3	25736	29868	419230	480935	423529
Aug.	W	9	6	6	6	4	104	89	115	131	144	31.79	31.29	32.44	35.77	36.97	8472	8339	137017	151053	135994
	MW	51	52	59	49	56	178	117	116	101	120	115.4	92.27	95	77.88	95.16	30753	24590	401198	328916	401870
Sep.	W	6	7	8	9	8	78	69	84	94	92	32.54	27.31	30.67	33.01	32.16	8672	7278	129507	139403	135801
	MW	73	53	48	36	53	238	125	122	82	134	137.6	92.64	92.98	63.99	93.07	36678	24688	392657	270241	393050
Oct.	W	8	6	7	6	8	101	67	89	79	86	33.06	23.44	28.77	26.32	30.05	8810	6247	121493	111137	126924
	MW	50	30	32	28	39	168	100	104	105	126	103.6	61.38	66.18	61.64	85.17	27600	16356	279481	260328	359707
Nov.	W	7	4	3	3	3	115	96	103	109	104	31.34	27.48	27.71	29.7	29.04	8351	7323	117023	125453	122639
	MW	15	16	16	12	18	98	103	106	123	135	49.36	54.33	52.23	33.83	63.76	13154	14479	220566	227347	269291
Dec.	W	5	6	6	5	6	117	104	109	91	105	29.83	29.42	27.91	25.04	26.58	7949	7839	117879	105745	112257
	MW	7	10	11	13	10	79	92	100	107	104	32.12	39.18	39.45	43.17	39.86	8558	10442	166617	182331	168338

Table 5. AVERAGE PRECIPITATION for the Western Utah population and the Wisconsin base site. W = Western Study Area (Utah), MW = Mid-western Study Area (Wisconsin base site) Time Frames: LGM = Last Glacier Maximum (22,000 years ago), MID = Mid-Holocene (6,000 years ago), CUR = current, 2050 = future prediction for year 2050, and 2070 = future prediction for year 2070.

		Majority Precip. (mm)					Median Precip. (mm)				
Month	Area	LGM	MID	CUR	2050	2070	LGM	MID	CUR	2050	2070
Jan.	W	13	14	13	12	13	26	27	23	23	21
	MW	16	23	21	22	19	19	25	25	27	21
Feb.	W	10	12	13	11	12	21	23	21	18	20
	MW	16	19	19	17	19	17	25	25	22	26
Mar.	W	12	22	22	23	22	24	30	28	29	29
	MW	32	61	53	80	48	38	59	37	77	60
Apr.	W	20	37	25	21	27	23	35	30	29	33
	MW	62	66	95	84	79	62	74	81	81	79
May	W	20	45	32	31	32	20	46	36	36	32
	MW	91	108	107	115	117	92	106	102	116	112
Jun.	W	20	29	25	29	28	23	33	29	34	31
	MW	99	115	109	107	120	99	114	107	122	121
Jul.	W	24	21	20	15	24	29	28	27	20	30
	MW	96	120	101	113	106	98	114	100	114	100
Aug.	W	25	18	24	22	23	29	27	28	30	31
	MW	118	97	102	79	98	117	95	98	79	97
Sep.	W	26	22	22	23	24	29	26	29	31	29
	MW	146	96	97	63	84	136	94	94	65	90
Oct.	W	26	17	25	22	28	29	22	26	24	28
	MW	91	58	64	55	88	100	60	65	60	85
Nov.	W	17	16	15	16	19	28	25	24	26	25
	MW	48	56	53	51	61	48	54	51	49	60
Dec.	W	12	14	13	13	14	27	25	24	20	22
	MW	24	30	29	34	30	28	34	35	38	35

Table 6. AVERAGE PRECIPITATION for Utah and Wisconsin study sites over different time periods. W = Western Study Area (Utah), MW = Mid-western Study Area (Wisconsin Base Site). Time Frames: LGM = Last Glacier Maximum (22,000 years ago), MID = Mid-Holocene (6,000 years ago), CUR = current, 2050 = future prediction for year 2050, 2070 = future prediction for year 2070.

	Minimum		Maximum		Mean	Standard Deviation	Mean	Standard Deviation
	1965-1989	1990-2014	1965-1989	1990-2014	1965-1989		1990-2014	
Western Population	-0.16	0.46	-0.02	0.67	-0.08	0.04	0.57	0.07
Mid-Western Population	-0.24	0.30	-0.12	0.40	-0.18	0.03	0.34	0.03

Table 7. From 1965-1989, the average temperature decreased slightly. From 1990-2014 the average temperature increased, with even the minimum change being an increase in 0.30°C on average.

AUTHOR BIOGRAPHY

Bethany Unger is a senior at Utah State University in the Quinney College of Natural Resources. She is studying wildlife science and geographic information systems with a multidisciplinary focus on all natural resources. In her free time, Bethany enjoys hiking, fishing, gardening, crocheting, and walking her dog. Future plans for Bethany include attending graduate school in a wildlife management or ecology program.